(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 647 725 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
19.04.2006 Bulletin 2006/16

(21) Application number: **05021666.2**

(22) Date of filing: **04.10.2005**

(51) Int Cl.:
F16C 11/06 *(2006.01)* ***F16C 25/02*** *(2006.01)*
B61F 5/16 *(2006.01)*

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **11.10.2004 GB 0422564**

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(54) **Wear adjustable spherical thrust bearing arrangement for bi-directional axial loads for coupling a bogie to a passenger car**

(57) A thrust bearing arrangement (13) for withstanding a bi-directional axial thrust, the arrangement comprising:

i) a bearing member (15) having concentric spherical inner (22) and outer (21) bearing surfaces;
ii) a spherical, thrust-bearing outer housing (14a) and a concentric, spherical, thrust-bearing inner housing (14b), the inner and outer bearing surfaces contiguously engaging with inner (25) and outer (20) counter surfaces associated with the inner and outer housings respectively; wherein
iii) the wear resistance of the inner and outer bearing surfaces is greater than the wear resistance of the inner and outer counter surfaces respectively such that, in use of the arrangement, any wear between the bearing surfaces and counter surfaces occurs to the respective counter surfaces

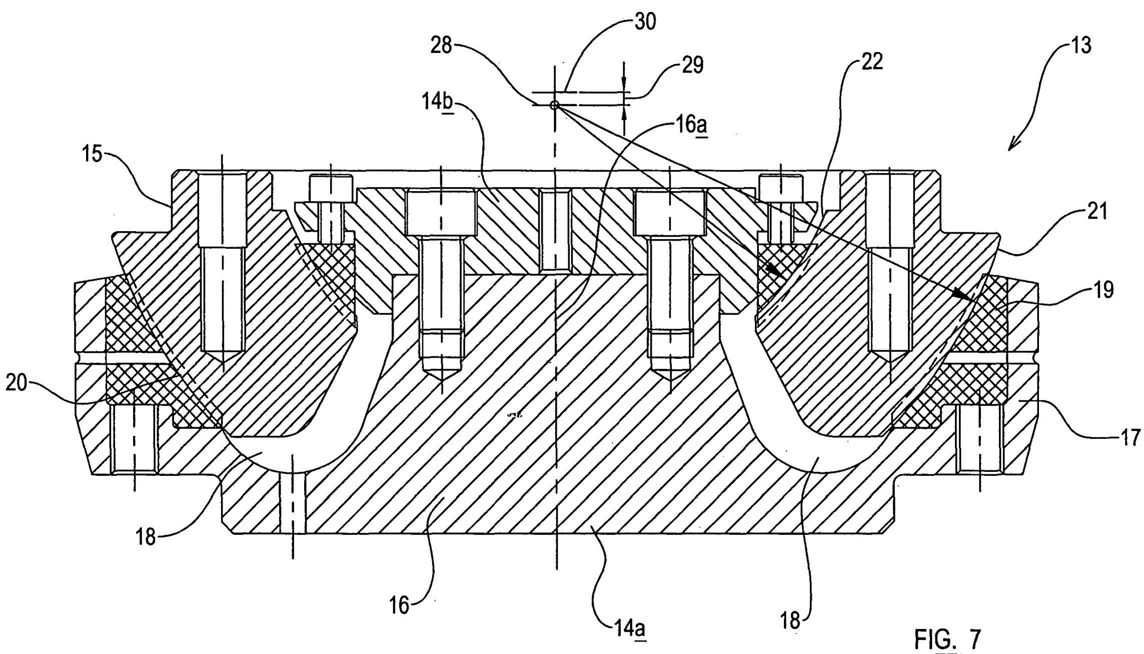

FIG. 7

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Description

[0001] The present invention relates to a thrust bearing arrangement for accommodating a bi-directional axial thrust and, in particular, a thrust bearing arrangement of the type generally used to couple two elements subject to relative rotation and yawing about a common axis, for example coupling a bogie to a passenger carriage.

[0002] The axial thrust-bearing requirements of coupling bearings between the passenger carriages of trains, trams, buses and coaches are dependent upon the particular type of passenger carriages being coupled together in a given case. Thus, for a large number of passenger carriage types, the coupling bearing is only subjected to an axial thrust directed vertically downwardly and, as such, the coupling bearing between the carriages need only be able to accommodate a thrust in a vertically downward direction. Such coupling bearings need only have a single bearing surface capable of bearing a vertically downward axial thrust.

[0003] However, in the case of certain types of carriages well known in the art, the associated coupling bearing is subjected to a bi-directional axial thrust, in particular a primary axial thrust in a vertical downward direction and a secondary axial thrust in a vertical upward direction, so that it is necessary to provide a coupling bearing which can accommodate both an upward axial thrust and a downward axial thrust.

[0004] Figure 1 of the accompanying drawings shows a bi-directional axial thrust bearing arrangement known in the prior art for coupling a bogie to a passenger carriage (not shown). The prior art arrangement comprises a generally toroidal bearing member 3, rigidly connected to a first connecting arm 1 from the bogie, having a first spherical bearing surface 4 and a second spherical bearing surface 5. The spherical bearing member 3 is received within a bearing housing 6 which comprises a first housing portion 6a rigidly connected to a second connecting arm 2 from the carriage and having a spherical bearing surface which is complementary to, and engages with, the bearing surface 4 of the spherical bearing member 3. The bearing housing 6 also comprises a "floating" housing portion 6b having a spherical bearing surface which is complementary to, and engages with, the spherical bearing surface 5 of the spherical bearing member 3. The housing portion 6b is secured to the connecting arm 2 by means of bolt 7 projecting down through a clearance hole 8 in the spherical bearing member 3 and housing portion 6a, and engaging with a complementary nut 9. Thus, the bolt 7 and nut 9 act to secure both of the housing portions 6a and 6b in engagement with the bearing surfaces 4 and 5 of the spherical bearing member 3.

[0005] It will be appreciated that, in the prior art arrangement shown in Figure 1, the coupling bearing between the connecting arms 1 and 2 is configured to withstand an axial thrust, occurring as a result of relative movement of the connecting arms 1 and 2, in both a downward axial direction (in which case housing portion 6a and thrust bearing member 3 bear the axial thrust) as well as an upward axial direction (in which case spherical bearing member 3 and housing portion 6b bear the axial thrust). It will further be appreciated that relative rotational movement about the central axis A (Figure 1) can be accommodated by the coupling bearing. In addition, and with reference to Figure 2, it will be appreciated that the coupling bearing can also accommodate a relative yawing motion of the two connecting arms about an axis B passing through the centre of curvature of the bearing surfaces 4 and 5.

[0006] It has been found that during operation of the prior art arrangement shown in Figure 1 over a given period of time, the bolt 7 and nut 9 tend to become loose, thereby allowing relative axial acceleration between the connecting arms 1 and 2 and subsequent undesirable stress on the securing bolt 7 and nut 9 which, unless remedied, may result in deformation or even shearing of the securing bolt 7, with consequent coupling bearing failure. In order to overcome the problem of potential coupling bearing failure due to the securing bolt becoming loose, it has been normal practice to tighten the securing bolt 7 and nut 9 at regular intervals, thereby re-engaging housing portions 6a and 6b with the spherical bearing member 3 and thus eliminating the problem of relative axial acceleration of the connecting arms 1 and 2. However, it has been found that, although relative axial acceleration of the connecting arms 1 and 2 is prevented by tightening the securing bolt 7 and nut 9, the securing bolt 7 and nut 9 are nevertheless still prone to deformation and possible shearing, with consequent coupling bearing failure; Thus, simply tightening the securing bolt 7 and nut 9 in the prior art arrangement shown in Figure 1 does not prevent unacceptable stresses being imposed on the securing bolt 7 and nut 9.

[0007] It is an object of the present invention to seek to provide an improved thrust bearing arrangement.

[0008] It has now been found, in accordance with the present invention, that the above noted deficiencies in the prior art arrangement of Figure 1 of the accompanying drawings can be attributed to the specific relationship between the geometry of the bearing arrangement in conjunction with the selected wear characteristics of certain components within the arrangement.

[0009] Thus, Figure 3 of the accompanying drawings shows the prior art arrangement of Figure 1 of the accompanying drawings after a given period of operation, during which time wear has occurred to the spherical bearing surface of the housing portion 6a. Consequently, the spherical bearing member 3 has dropped, to re-engage with the spherical bearing surface of the housing portion 6a, thus tending to create a gap 10 between the housing portion 6b and the bearing surface 5 of the spherical bearing member 3. It is noted that, in the momentary (schematic) position shown in Figure 3 of the accompanying drawings, wherein the housing portion is shown in its original position prior to wear, the centre of curvature of the spherical bearing surface of the housing portion

6b is offset with respect to the centre of curvature of the spherical bearing surface of the housing portion 6a, which has now effectively "dropped" downward due to wear by the spherical bearing member 3.

[0010] Figure 4 shows the situation after the housing portion 6b has also dropped to fill the gap 10 which is shown in Figure 3. In such a position, a corresponding gap 11 develops between the nut 9 and the connecting arm 2. However, because the housing portion 6b has effectively dropped by an equal amount to the spherical bearing member 3, which has in turn dropped by an equal amount to the "drop" in the spherical bearing surface of the housing portion 6a, the centres of curvature of the spherical bearing surfaces of the housing portions 6a and 6b are once again coincidental with one another.

[0011] Thus, successive wearing due to a downward axial thrust acts to maintain the centres of curvature of the spherical bearing surfaces of the housing portion 6a and 6b coincidentally with one another.

[0012] However, over the same operating period, axial thrust in an upward direction will cause wear to the bearing surface 5 (due to the relative wear resistance of the spherical bearing member 3 and housing portion 6b) and, as shown in Figure 5, such wear to the bearing surface 5 will result in the housing portion 6b dropping a further distance to once again re-engage with the bearing surface 5, with the result that an increased gap 12 is formed between the nut 9 and the connecting arm 2. Critically, because the wear to the bearing surface 5 results in a drop of the housing portion 6b, but no associated drop of the spherical bearing member 3, the centres of curvature of the spherical bearing surfaces of the housing portions 6a and 6b subsequently become axially displaced with respect to one another, so that in the prior art arrangement of Figures 1 to 5, it can be seen that wear caused by an axial upwardly directed thrust actually acts to offset the centres of curvature of the spherical bearing surface of the bearing housing 6, with the result that the spherical bearing surfaces are no longer concentric.

[0013] Referring again to Figure 5, it will be appreciated that, due to the formation of gap 12, the connecting arms 1 and 2 are free to accelerate relative to one another so that an impact load is generated upon consequent impact of either the connecting arm 2 with the nut 9 or, alternatively the bearing surface 5 with the housing portion 6a.

[0014] In addition, and with reference to Figure 5, it can now be appreciated that wear occurring within the coupling bearing arrangement of Figure 1 of the accompanying drawings can result in a fundamental change in the bearing geometry of the arrangement, which alters the performance characteristics of the bearing. Thus, because the spherical bearing surfaces of the housing portion 6a and housing portion 6b are no longer concentric with one another, relative rotation or yawing motion of the connecting arms 1 and 2 about axes A and B respectively will now necessarily result in upward axial force being imposed on the housing portion 6b, due to the spherical bearing member acting as a spherical "wedge". Thus, if the bearing is left loose, relative rotation or yawing of the connecting arms 1 and 2 about axes A and B will itself produce relative axial movement of the connecting arms and a consequent impact loading on the nut 9 and housing portions 6a. Furthermore, if the securing bolt 7 and nut 9 are tightened to ensure engagement of housing portions 6a and 6b with spherical bearing surfaces 4 and 5 of the spherical bearing member 3 then, although relative acceleration of the connecting arms 1 and 2 may be avoided, the modified geometry of the bearing arrangement will now result in an axial force being generated along the central axis A, thereby placing stress upon the securing bolt 7 and nut 9 which may lead to the aforementioned deformation or shearing of the securing bolt 7 and consequent coupling bearing failure.

[0015] According to the present invention there is provided a thrust bearing arrangement for withstanding a bidirectional axial thrust, the arrangement comprising a bearing member having concentric spherical inner and outer bearing surfaces; a spherical, thrust-bearing outer housing and a concentric, spherical, thrust-bearing inner housing, the inner and outer bearing surfaces contiguously engaging with inner and outer counter surfaces associated with the inner and outer housings respectively; wherein, the wear resistance of the inner and outer bearing surfaces is selected so as to be greater than the wear resistance of the inner and outer counter surfaces respectively such that, in use of the arrangement, wear between the bearing surfaces and counter surfaces occurs predominantly to the respective counter surfaces.

[0016] Advantageously, a thrust bearing arrangement according to at least one of the inner and outer counter surfaces is defined by the respective housing.

[0017] Preferably, at least one of the inner and outer counter surfaces is defined by a bearing liner attached to the respective housing.

[0018] In a preferred embodiment, the thrust bearing arrangement is provided with adjustment means for adjusting the relative separation of the counter surfaces to maintain both of the inner and outer counter surfaces in contiguous engagement with the respective inner and outer bearing surfaces.

[0019] In a yet further preferred embodiment, the adjustment means is in the form of a first screw threaded member associated with the inner counter surface and a second screw threaded member associated with the outer counter surface, the first screw threaded member being complementary, and engaging with a screw-threaded bore of the second screw threaded member.

[0020] Preferably, the first screw-threaded member is in the form of an adjustment screw projecting at one end through a complementary screw-threaded bore in the second screw-threaded member, the projecting end of the adjustment screw being operably connected to one of said counter surfaces such that rotation of the adjustment screw advances said counter surface towards the other counter surface.

[0021] Advantageously, the first screw-threaded member is in the form of an adjustment screw projecting through a clearance hole in each of the bearing housings and thrust bearing member, and the second screw-threaded member is in the form of an adjustment nut engaging with the projecting end of the adjustment screw opposite the screw head.

[0022] Conveniently, the adjustment arrangement comprises a bias means to resiliently bias the inner and outer counter surfaces towards one another so as to ensure said maintenance of the inner and outer counter surfaces in contiguous engagement with the respective bearing surfaces.

conveniently, the outer housing has a base and a central post upstanding from the base, the central post being integrally formed with the housing, the inner housing being mounted on the central post, wherein there is further provided a number of threaded holes in the central post and a corresponding number of bores through the inner housing each to align with a corresponding threaded hole, and locking screw is fastened in each hole and bore to attach the inner housing to the central post.

[0023] Preferably, each locking screw is countersunk into the inner housing.

[0024] Conveniently, at least one fixture is provided on the outer housing to mount the outer housing to a first element and wherein at least one fixture is provided on the spherical bearing member to mount the spherical bearing member to a second element.

[0025] In a preferred embodiment, the first element is associated with a bogie of a vehicle and the second element is associated with a carriage of the vehicle.

[0026] Figure 1 shows a cross sectional view of a thrust bearing arrangement according to the prior art in an operative position coupling together two loads.

[0027] Figure 2 shows a cross sectional view of the prior art arrangement of Figure 1, illustrating how the arrangement accommodates a yawing motion between the two loads.

[0028] Figure 3 shows a cross sectional view of the prior art arrangement of Figure 1 which schematically illustrates the initial effect of bearing surface wear due to a downwardly directed axial thrust.

[0029] Figure 4 shows a cross sectional view of the partly worn bearing arrangement of Figure 3, illustrating the progressive effects of bearing surface wear due to a downwardly directed axial thrust.

[0030] Figure 5 shows a cross sectional view of the partly worn arrangement of Figure 4, but further illustrating the effect of an additional bearing surface wear due to an upward axial thrust.

[0031] Figure 6 shows a cross sectional view of a thrust bearing arrangement according to the present invention prior to bearing surface wear.

[0032] Figure 7 shows the thrust bearing arrangement of Figure 6 but subject to bearing surface wear due to both an upward and downward directed axial thrust.

[0033] Referring now to Figure 6, a thrust bearing arrangement 13 is provided according to the present invention comprising, generally, a bearing housing arrangement 14 configured to be mounted to a first given element and a bearing member 15 configured to be mounted to a second given element so as to couple together the two elements (for example a carriage and a bogie) in a similar manner to the prior art arrangement of Figures 1 to 5.

[0034] The bearing housing arrangement 14 comprises an outer housing 14a incorporating a central base portion 16 and peripheral ring portion 17 which together define an annular recess 18. A central post 16a extending upwardly from the base portion 16 to approximately the same level as the upper edge of ring portion 17. A bearing liner 19, preferably in the form of a conventional preformed, thermoplastic lubricating liner, is mounted to the rim portion 17 of the outer housing portion 14a and is configured to present a continuous, annular counter surface 20 which is spherical, in the sense that it forms at least a portion of the surface of an imaginary sphere.

[0035] Bearing member 15 is in the form of an annular bearing member having an outer bearing surface 21 and an inner bearing surface 22 which are both spherical, in the sense that they define at least a portion of the surface of an imaginary sphere, and which are also concentric with one another, in the sense that the centre of curvature of the associated imaginary spheres, indicated at 30 in Figure 6, are coincidental with one another. The annular bearing member 15 fits over the central hub portion 16 of the outer housing 14a to contiguously engage with the counter surface 20 of the liner 19. Thus, the counter surface 20, defined by the liner 19, represents an outer counter surface associated with the outer housing 14a.

[0036] The bearing housing 6 arrangement 14 is also provided with an inner housing 14b in the general shape of a truncated upturned dome having an annular recess 23 configured to receive a further annular bearing liner 24 having a continuous counter surface 25 which is spherical, in the sense that it forms at least a portion of the surface of an imaginary sphere.

[0037] The inner housing 14b has a cylindrical recess 28 at its lower end which receives the top section of the central 16a (see Figure 6). Thus the inner housing 14b is mounted on the central post 16a.

[0038] In the example shown in Figure 6, two bores 29 are provided in the inner housing 14b which align with corresponding threaded holes 31 provided in the post 16a. Locking screws 32 pass through the bores 29 in the inner housing 14b and are screwed into the threaded holes 31 in the central post 16a. Preferably, the locking screws 32 are countersunk into the body of the inner housing 14b so that the upper surface of the inner housing 14b has a flush profile.

[0039] Adjustment screws 27 (of which two are shown in Figure 6) are mounted within screw threaded holes in the inner housing 14b opening on to the recess 23 such that the adjustment screws 27 may be screwed downwards to abut against the liner 24 and ensure a positive contiguous engagement of the counter surface of liner 24 with the inner bearing surface 22 of the bearing member 15. Thus, it will be appreciated that the counter surface defined by the liner 24 represents an inner bearing counter surface associated with the inner housing 14b. It is noted that the adjustment screws 27 may be progressively screwed downward to move the liner 24 towards the liner 19 and, as such, adjustment screws 27 and inner housing 14b effectively represent first and second complementary screw threaded members, associated respectively with the inner and outer counter surfaces, 20 and 25, which together form an adjustment means for adjusting the relative separation of the inner and outer counter surfaces (i.e. counter surfaces 25 and 20) to maintain both the inner and outer counter surfaces in contiguous engagement with the respective inner and outer bearing surfaces 22 and 21 of the bearing member 15.

[0040] Wear characteristics of the bearing member 15 are selected so that the wear resistance of the bearing surfaces 21 and 22 are greater than the respective wear resistances of counter surfaces 20 and 25. Preferably, wear resistances of the bearing surfaces 21 and 22 and counter surfaces 20 and 25 are selected so that wear occurring predominantly to counter surfaces 20 and 25 occurs at an identical rate; in particular, it is envisaged that, on the one hand, the wear resistance of the bearing surfaces 21 and 22 is selected to be identical and, on the other hand, the wear resistance of the counter surfaces 20 and 25 is also selected to be identical so that the two sets of bearing/counter surfaces are identical.

[0041] It will be appreciated, with reference to Figure 6, that the configuration of the thrust bearing arrangement is such that it can accommodate both a relative rotational motion of the bearing housing 14 and bearing member 15 about the central axis C, as well as a relative pivoting or yawing motion of the bearing housing 14 and bearing member 15 about the perpendicular axis D (running through the centre of curvature of bearing surfaces 20, 21, 22 and 25).

[0042] Referring now to Figure 7, the bearing arrangement is shown after operation over a given period of time, during which the arrangement has been subjected to an axial thrust both in a downward direction, tending to force the bearing member 15 against the liner 19, and an upward direction, tending to force the bearing member 15 against the liner 24.

[0043] It can be seen, from Figure 7, that, due to the relative wear resistances of bearing surface 21 and counter surface 20, subjecting the bearing arrangement to a downward axial thrust results in a progressive wearing of the liner 19 (as indicated by the dotted lines in Figure 7). In addition, it can be seen that, due to the relative wear resistances of bearing surface 22 and counter surface 25, subjecting the bearing arrangement to an upward axial thrust results in a progressive wearing of the liner 24 (indicated by the dotted lines in Figure 7). Specifically, it is to be noted that any wear between the bearing surfaces 21 and 22 and the respective inner and outer counter surfaces (20 and 25) occurs to the respective counter surface and not to the bearing surfaces 21 and 22 of the bearing member 15. Thus, it will be appreciated that the bearing member 15 will, essentially, retain its specific shape and, in particular, the spherical bearing surfaces 21 and 22 will, crucially, remain concentric with one another. Therefore, when the counter surface 25 of the liner 24 is re-engaged with the bearing surface 22 of the bearing member 15, each of the bearing surfaces 21, 22 and counter surfaces 20, 25 will, necessarily, still be concentric with one another, albeit about a new centre of curvature 28, axially offset by a distance 29 from the original centre of curvature 30 corresponding to the axial "drop" of the spherical bearing member 15 due to wear of the liner 19.

[0044] Thus, the selected wear resistances of the bearing surfaces 21, 22 and counter surfaces 20, 25, in conjunction with the geometry of the bearing arrangement 13, ensure that the bearing arrangement 13 may still accommodate a relative rotation about the central axis C and relative yawing motion about the axis D (see Figure 6), without generation of an associated axial thrust, despite wear occurring at the counter surfaces, so that even where the bearing arrangement 13 is left "loose", relative axial movement of the bearing member 15 and bearing housing 14 due to rotational and/or yawing motion is eliminated. Consequently, it is possible to maintain the liner 19 and liner 24 in positive engagement with the bearing member 15, by means of adjustment screws 27, thereby eliminating relative axial acceleration of the bearing member 15 and bearing housing 14, whilst also preventing undesirable stress being imposed upon the securing bolt 26 in the case of relative rotation or yawing motion of the bearing member 15 and housing 14.

[0045] It is envisaged that the bearing housing may take any one of a number of possible forms and, in particular, is not limited to the particular configuration of bearing housing arrangement 14. By way of another example, the bearing housing might take the form of a housing arrangement similar to housing 6 shown in the prior art arrangement of Figures 1 to 5. That is, the housing arrangement may comprise an outer housing which is similar to outer housing 14a, in conjunction with an inner housing which is a "floating" housing similar to housing portion 6b of the prior art arrangement, with the two housings being secured to one another by means of a bolt and nut similar to securing bolt 7 and nut 9 of the prior art arrangement of Figures 1 to 5.

[0046] Furthermore, it is envisaged that the inner and outer counter surfaces 25 and 20, defined respectively by the liners 24 and 19 in the particular embodiment of Figures 6 and 7, could take any one of a number of alternative forms, provided only that they present a spherical counter surface to contiguously engage with the spherical bearing surfaces of the bearing member 15. Thus, the inner and outer counter surfaces may in fact be formed integrally with the inner and outer housing, for example the housings may be formed so as to have integral spherical counter surfaces, which could either define a "direct" (unlined) pair of counter surfaces or which could subsequently be lined directly with a conventional bearing liner.

[0047] Similarly, it is envisaged that the adjustment means to move the inner and outer counter surfaces relative to one another could take any one of a number of alternative forms and, where the housing comprises a "floating" housing portion in similar manner to the prior art arrangement of Figures 1 to 5, it is envisaged that the securing bolt and nut used to secure the floating housing portion to the remainder of the bearing housing could themselves represent complementary screw threaded members which act as an adjustment means operable to move the inner and outer counter surfaces of the bearing housing relative to one another to ensure contiguous engagement of the counter surfaces with the respective bearing surfaces of the bearing member.

[0048] Indeed, in one particular preferred embodiment, it is envisaged that the inner and outer counter surfaces may be resiliently biased towards one another, for example by a spring arrangement (not shown) such that any gap which tends to form between the bearing member and the counter surfaces is automatically "closed" by the spring arrangement, which acts to maintain the inner and outer counter surfaces in positive contiguous engagement with the bearing member without the need for manual adjustment.

[0049] When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

Claims

1. A thrust bearing arrangement (13) for withstanding a bi-directional axial thrust, the arrangement (13) comprising:

    a bearing member (15) having concentric spherical inner (22) and outer (21) bearing surfaces; a spherical, thrust-bearing outer housing (14a) and a concentric, spherical, thrust-bearing inner housing (14b), the inner (22) and outer (21) bearing surfaces contiguously engaging with inner (25) and outer (20) counter surfaces associated with the inner (14b) and outer (14a) housings respectively;

    characterised in that:

    the wear resistance of the inner (22) and outer (21) bearing surfaces is selected so as to be greater than the wear resistance of the inner (25) and outer (20) counter surfaces respectively such that, in use of the arrangement (13), wear between the bearing surfaces (22,21) and counter surfaces (25,20) occurs predominantly to the respective counter surfaces (25,20).

2. A thrust bearing arrangement (13) according to claim 1, wherein at least one of the inner (25) and outer (20) counter surfaces is defined by the respective housing (14b,14a).

3. A thrust bearing arrangement (13) according to claim 1 wherein at least one of the inner (25) and outer (20) counter surfaces is defined by a bearing liner (24,19) attached to the respective housing (14b, 14a).

4. A thrust bearing arrangement (13) according to claims 1 to 3, wherein the arrangement is further provided with adjustment means (14b,26,27,32) for adjusting the relative separation of the counter surfaces (25,20) to maintain both of the inner (25) and outer (20) counter surfaces in contiguous engagement with the respective inner (22) and outer (21) bearing surfaces.

5. A thrust bearing arrangement (13) according to claim 4, wherein the adjustment means is in the form of a first screw threaded member (27) associated with the inner counter surface (25) and a second screw threaded member (14b,26,32) associated with the outer counter surface (20), the first screw threaded member (27) being complementary, and engaging with, a screw-threaded bore of the second screw threaded member (14b,26,32).

6. A thrust bearing arrangement (13) according to claim 5, wherein the first screw-threaded member is in the form of an adjustment screw (27) projecting at one end through a complementary screw-threaded bore in the second screw-threaded member (14b,26,32), the projecting end of the adjustment screw (27) being operably connected to one of said counter surfaces (20,25) such that rotation of the adjustment screw (27) advances said counter surface (20,25) towards the other counter surface (25,20).

7. A thrust bearing arrangement (13) according to claim 5, wherein the first screw-threaded member is in the form of an adjustment screw projecting through a clearance hole in each of the bearing housings (14a, 14b) and thrust bearing member (15), and the second screw-threaded member is in the form of an adjustment nut engaging with the projecting end of the adjustment screw opposite the screw head.

8. A thrust bearing arrangement (13) according to any one of claims 4 to 7, wherein the adjustment arrangement comprises a bias means to resiliently bias the

inner (25) and outer (20) counter surfaces towards one another so as to ensure said maintenance of the inner (25) and outer (20) counter surfaces in contiguous engagement with the respective bearing surfaces (21,22).

9. A thrust bearing arrangement (13) according to any preceding claim, wherein the outer housing (14a) has a base (16) and a central post (16a) upstanding from the base (16), the central post (16a) being integrally formed with the housing (14a), the inner housing (14b) being mounted on the central post (16a), wherein there is further provided a number of threaded holes (31) in the central post (16a) and a corresponding number of bores through the inner housing (14b) each to align with a corresponding threaded hole (31), and locking screw (26) is fastened in each hole (31) and bore to attach the inner housing (14b) to the central post (16a).

10. A thrust bearing arrangement (13) according to claim 9, wherein the or each locking screw (26) is countersunk into the inner housing (14b).

11. A thrust bearing arrangement (13) according to any preceding claim, wherein at least one fixture is provided on the outer housing (14a) to mount the outer housing (14a) to a first element and wherein at least one fixture is provided on the spherical bearing member (15) to mount the spherical bearing member (15) to a second element.

12. A thrust bearing arrangement (!3) according to claim 11, wherein the first element is associated with a bogie of a vehicle and the second element is associated with a carriage of the vehicle.

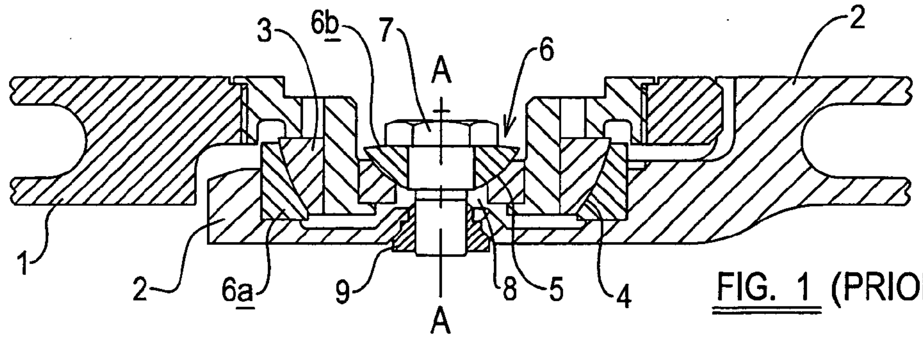

FIG. 1 (PRIOR ART)

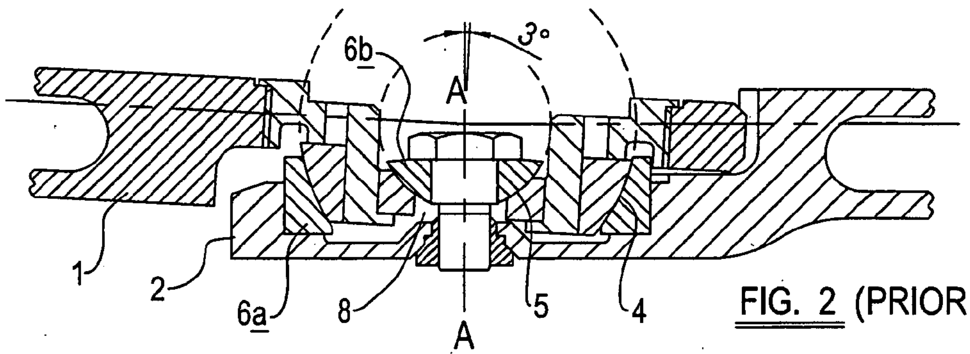

FIG. 2 (PRIOR ART)

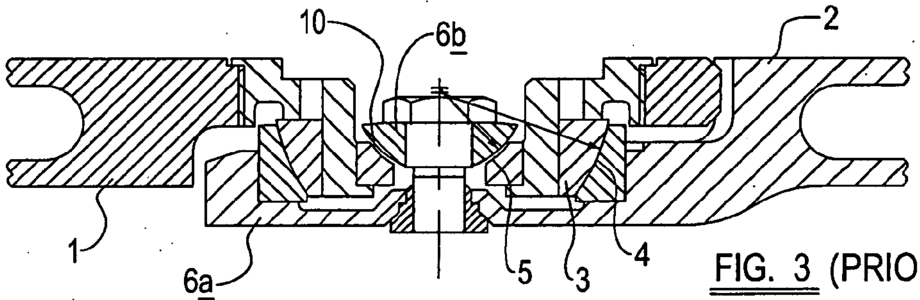

FIG. 3 (PRIOR ART)

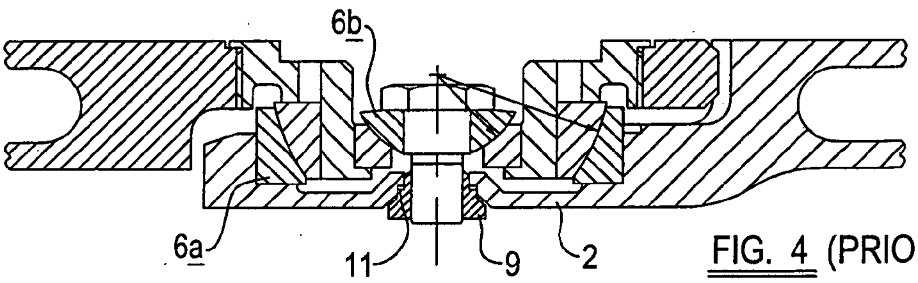

FIG. 4 (PRIOR ART)

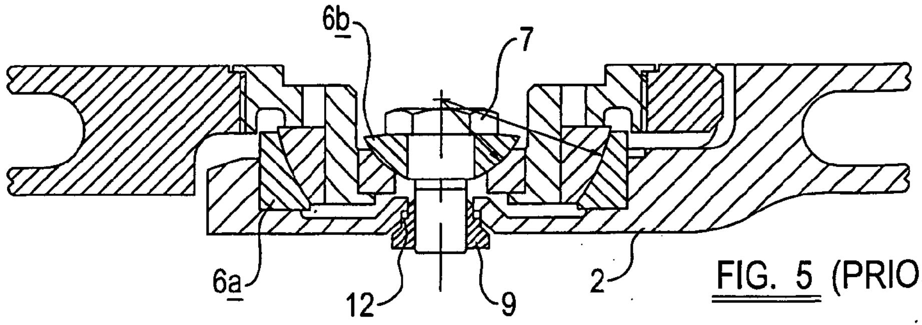

FIG. 5 (PRIOR ART)

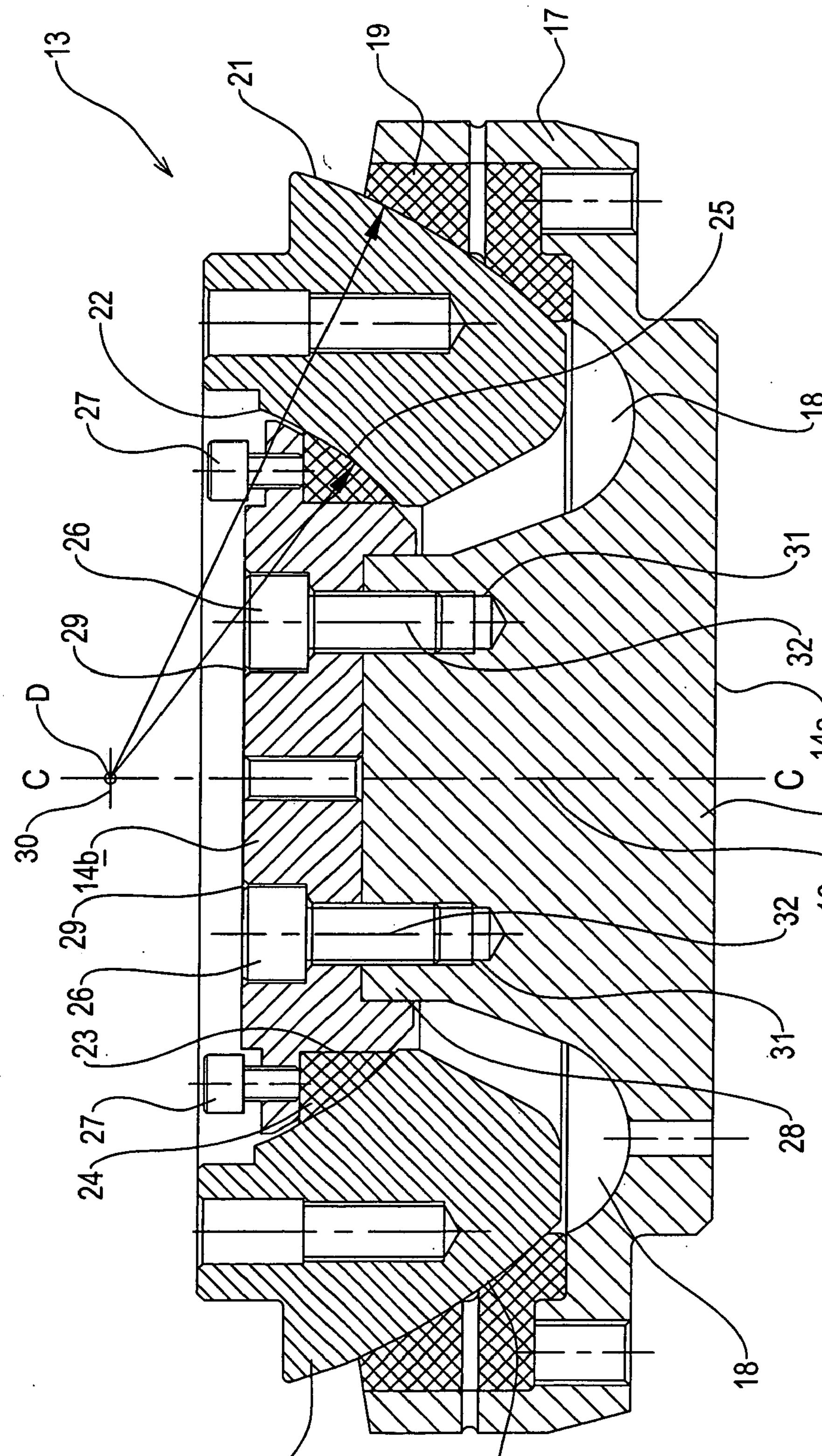

FIG. 6

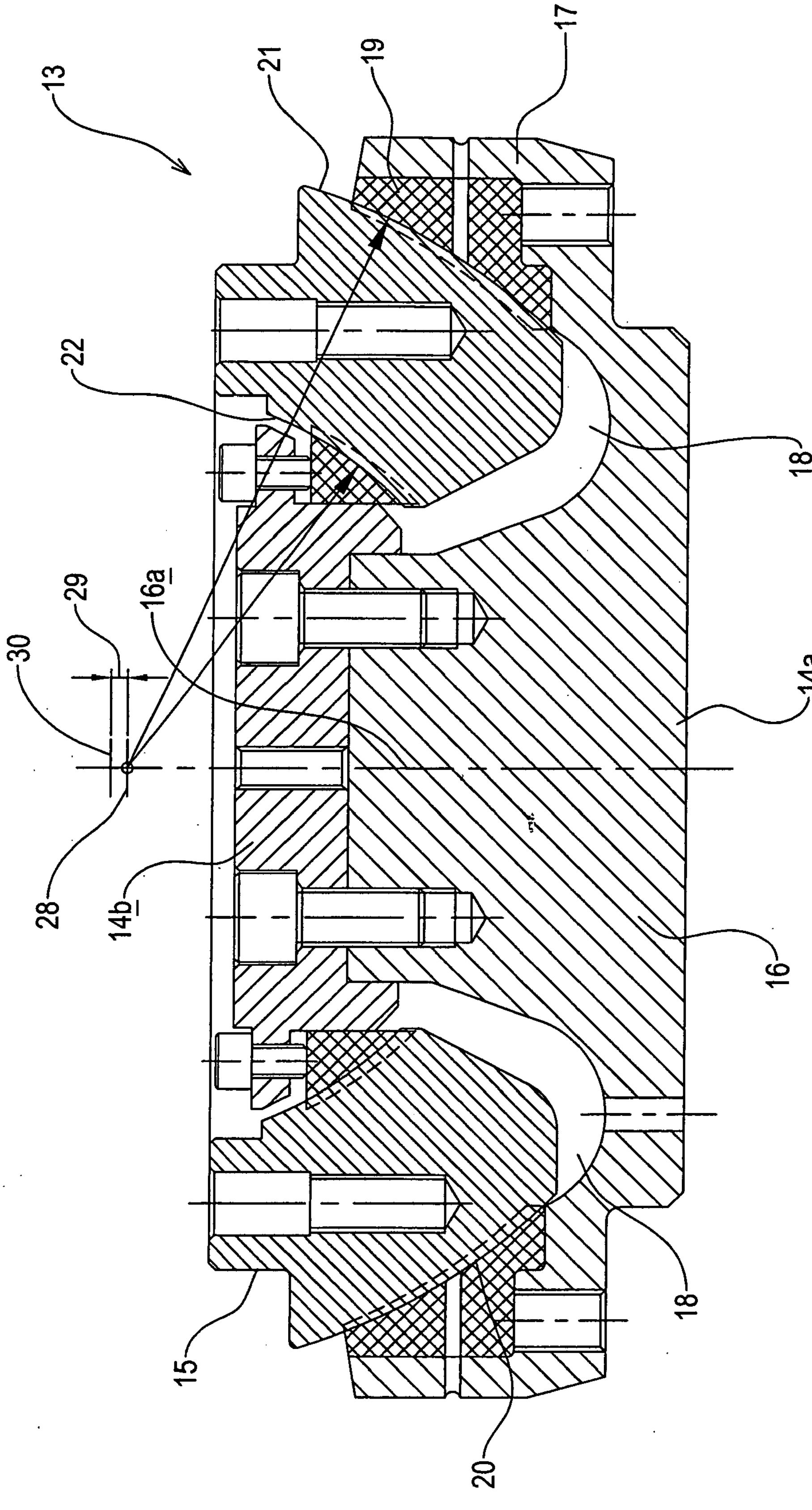

FIG. 7